Space Weather Technical Forecast

Issued on Friday, 22 September 2023 at 01:22 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Isolated R1-R2 Minor/Moderate Radio Blackouts likely throughout. Chance of G1 minor geomagnetic storms Day 1 and 2 (22 and 23 Sep).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate over the past 24 hours, with the peak flare reaching M8.7 at 21/1254 UTC from AR3435. This region, in the northeast, is the largest sunspot region and maintains magnetic complexity with a north-south magnetic alignment as well as a small delta spot on the southern edge. Another region, with north-south magnetic complexity is AR3441 (Cri/Beta-Gamma) in the northwest, although this has remained relatively stable over the past 24 hours. The most notable region of growth is in the northwest with AR3443 maturing to be classified Dai/Beta. A region of slower growth is AR3438, which is just to the west of AR3435 in the northeast quadrant. This region has now developed some rudimentary penumbra, which possibly contains a small delta spot. All other regions on the disc currently remain small or simple with no significant change observed.
A faint CME associated with the M8.7 flare from AR3435 can be seen departing the Sun towards the south and east. This feature is currently being analysed, but it is thought likely that it will have an Earth directed component. A further CME is seen leaving the northeast limb of the Sun shortly afterwards, but this is unlikely to be Earth directed.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by ACE and DSCOVR at L1, showed a steady decline through the period from around 440km/s to around 400km/s. The solar wind density has been below average (<5 ppcc). The IMF was weak throughout, with the north-south component (Bz) varying weakly between -4 and +4nT. The phi angle showed periodic fluctuations between positive (away from the Sun) and negative (towards the Sun) sectors. Resultant Geomagnetic activity was at Quiet to Unsettled levels (Kp1-3).

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was at background levels. GOES16 high energy (greater than 2MeV) electron flux was generally at moderate levels, but rose to High between 21/1640 UTC and 21/1900 UTC, with a peak of 1420 pfu at 21/1740 UTC. The associated 24-hour fluence was below the Active (1e8 integrated pfu) threshold, with a steady decreasing trend to 2.75e7 integrated pfu observed at 22/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to remain at Low to Moderate levels. There is a continued chance of further isolated M-class flares, with the greatest risk continuing to come from AR3435 in the northeast and the developing regions AR3438 and AR3443.

Solar Wind / Geomagnetic Activity: Solar winds are currently close to ambient levels, but coronal hole fast winds and minor CME effects are likely to impact the forecast later on Day 1 through to Day 3 (22-24 Sep). Predominantly Quiet Geomagnetic activity is likely to increase to

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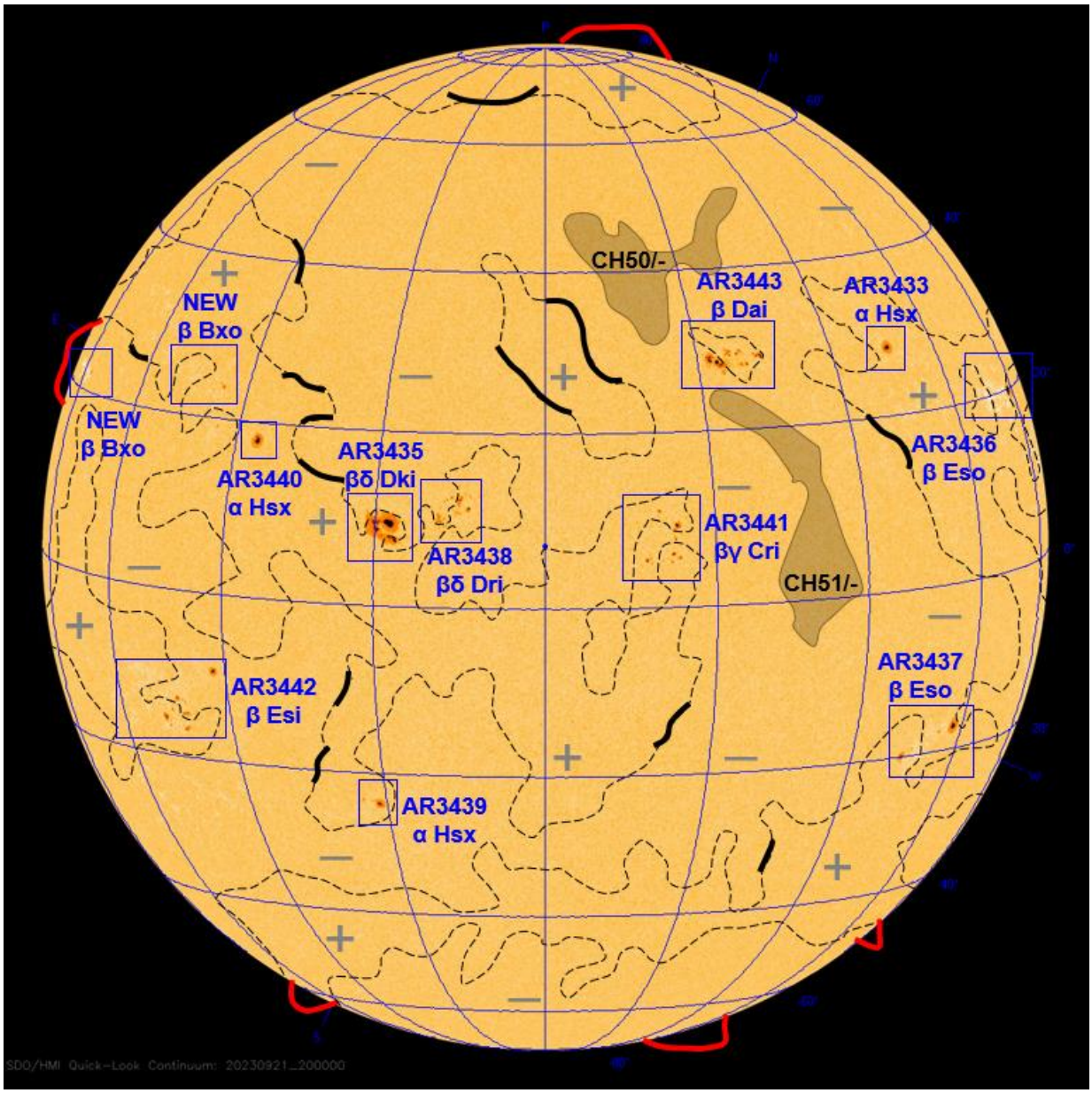
Unsettled to Active levels later on Day 1, with a chance for G1 Minor Storm intervals, most likely on day 2 (23 Sep) due to a possible glancing impact from a CME. On days 3 and 4 (24 and 25 Sep) activity should gradually decline towards Quiet to Unsettled levels.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is expected to remain at Background levels, with a daily slight chance of an enhancement should any larger flares occur. High energy (greater than 2 MeV) electron flux is likely to become suppressed before rising towards High levels again later in the forecast period. The 24-hour fluence is likely to remain below the (1e8 integrated pfu) Active threshold throughout the period, but with a rising possible towards the end.

Figure 1. Solar Analysis Valid 21/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Met Office Space Weather Technical Forecast

Geomagnetic Storms:

A CME from an M-class flare that departed the sun towards the southeast on 19 Sep has been analysed, with a slight chance to give a glancing blow to Earth late on Day 1 (22 Sep) or early on Day 2 (23 Sep). A second CME associated with the M8.2 flare from AR3435 on 20 Sep also departed the Sun towards the southeast. Although it was largely southward directed, a glancing impact of Earth is considered likely on Day 2 or 3 (23 or 24 Sep). Timing is uncertain for this CME as a leading, faster shock in evidence in LASCO imagery is followed by a slower feature that appears to contain the bulk of the ejected material.
Effects from the CME that influenced the near Earth environment from 18 Sep have now eased, with a close to ambient solar wind regime in evidence at GEO. The next HSS that looks likely to connect with the Earth is CH51/-, a recurrent feature, which is currently situated close to the equator west of centre disc. This should give an increase in solar winds at GEO later on Day 1 (22 Sep) into Day 2 (23 Sep) to Slightly Elevated or Elevated levels. Enlil now demonstrates improved modelling of this feature in terms of onset time and peak speeds. The negative polarity of the coronal hole isn't conducive for significantly enhanced geomagnetic activity at this time of year. A transition into the fast wind of CH50/- in the northern hemisphere may take place on Days 3 and 4 (24 and 25 Sep), although this maybe largely indistinguishable from waning effects of CH51/-.
Predominately Quiet geomagnetic activity is likely to become Unsettled to Active later on Day 1 (22 Sep) into day 2 (23 Sep) due to the influence of CH51/-, possibly combined with glancing CME effects. There is a chance of G1 Minor storm intervals, most likely during the possible arrival of the CME on the 23rd (Day 2). On days 3 and 4 (24 and 25 Sep) activity should gradually decline towards Quiet to Unsettled.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	30	10	1
Strong	G3	No	1	5	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
20/0315	Partial	Flare	NE (AR3435)	515 km/s	22/23 Sep	Slight chance of glancing impact
20/2051	Partial	Flare	NE (AR3435)	560 km/s	23/1700 UTC +/- 9hrs	Moderate confidence of glancing impact

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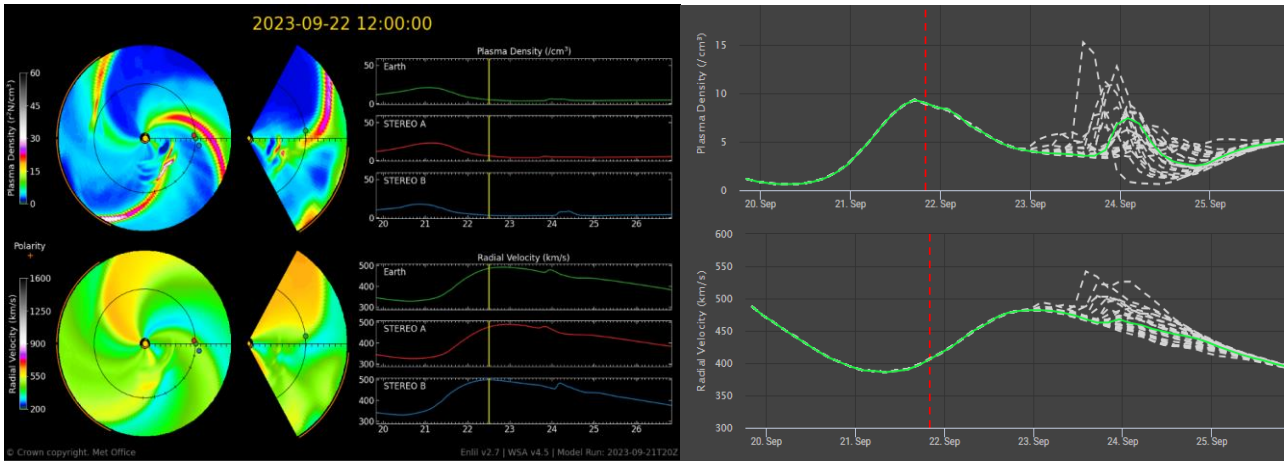
Figure 2: MOSWOC Enlil and ensemble, showing coronal hole high speed stream as well as possible CME arrival.



Radio Blackouts - X-Ray Flares:

There are presently thirteen active regions on the visible disc, three of which remain unnumbered. The largest and most active region on the disk is AR3435 (Dki/Beta-Delta) in the northeast. This region was responsible for the M8.7 flare peaking at 21/1254 UTC. Continuing magnetic complexity is evident with a north-south magnetic alignment likely aiding shear instability, as well as a small delta spot on the southern edge. Another region, with north-south magnetic complexity is AR3441 (Cri/Beta-Gamma) in the northwest, although this has remained relatively stable over the past 24 hours. The most notable region of growth is in the northwest with a newly numbered sunspot, AR3443, having emerged rapidly, with the growth of numerous small spots and penumbra maturing on both ends of the group. A region of slower growth is AR3438, which is just to the west of AR3435 in the northeast quadrant. This region has now developed some rudimentary penumbra, which possibly contains a small delta spot. All other regions on the disc currently remain small or simple.
Solar activity is expected to remain at Low to Moderate levels. There is a continued chance of further isolated M-class flares and a slight chance of an X-flare. AR3435 is the most likely source of further activity, as well as the developing regions of AR3438 and AR3443.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	60	60	60
Very Active	R3 to R5 X Class	No	10	10	10	10

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Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is expected to persist at Background levels, but with a daily slight chance of flux levels rising in response to any significant flaring.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy (greater than 2MeV) electron flux levels have recently been varying between Moderate and High levels. This is likely to become suppressed later on Day 1 (22 Sep) as geomagnetic activity increases in response to the arrival of coronal hole fast winds and possible glancing CME influences. A return to high levels is possible later on Day 3 and Day 4 (24 and 25 Sep).

The 24-hour electron fluence is currently below the Active threshold and is likely to remain at this level, with the current MOSWOC REFM output forecast providing reasonable guidance. However a rising trend is likely later in the period, giving a chance of Active fluence levels.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	20	10	20	40
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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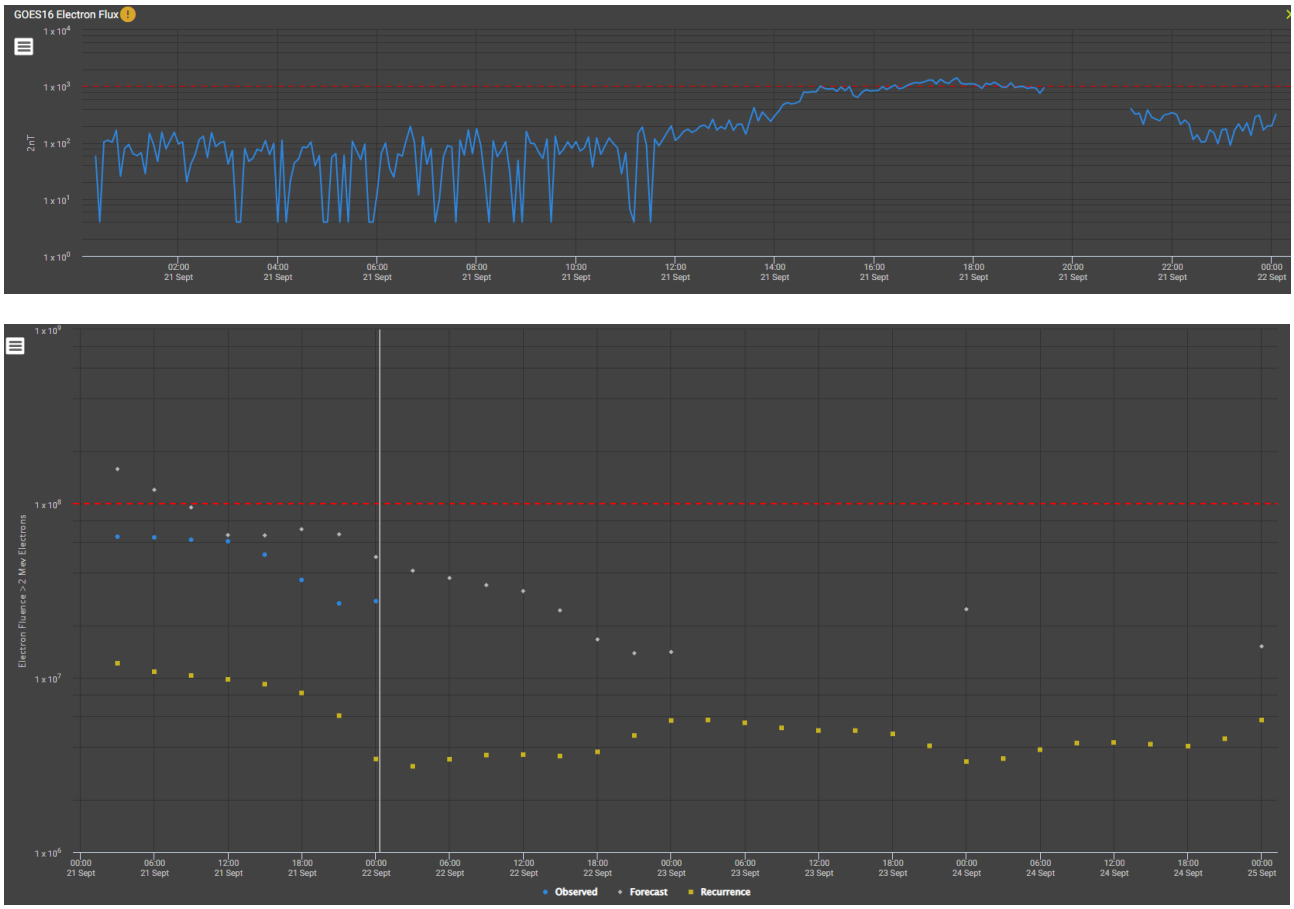
Figure 3: GOES-16 Observed electron flux and fluence, as well as REFM and recurrence data



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